STRESSES ON BRACKET AND CONNECTION COMPONENTS IN ELEVATORS

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ABSTRACT

Strength values are of importance during braking and running process in elevator. Firstly, materials should counter these stresses in safe values. This is compulsory for the resistance of materials. Secondly, deflections occurring in these materials should not exceed certain values. When the deflection exceeds brake lag distance, the brakes of elevator can fail and this deactivates the most important safety system. Stresses on brackets and connection pieces are important so as rail calculations. Thus the calculations should be done consciously.

1. INTRODUCTION

Guidance of car and counter weight or balance weight -if used- in elevators is very important. Especially in elevators featuring angle less than 15^0 vertically within the scope of EN 81-20, this issue was stated in the following article of the standard.

*“ **EN 81-20, 5.7.1.1** The car, counterweight or balancing weight shall each be guided by at least two rigid steel guide rails.*
***5.7.1.2** The guide rails shall be made from drawn steel, or the rubbing surfaces shall be machined”*

Another important issue for the elevators within this scope is safety mechanisms (Here I mean only safety gear and overspeed governor, not the others like buffers or door locks). An elevator to carry passengers should certainly have a safety mechanism. It is not allowed for elevator to carry passenger as long as this safety mechanism is active (Directive 2014/33 Annex I). It is compulsory to use a safety mechanism with a capacity suitable to rated load and rated speed in elevators. In order to take the elevator into operation, safety mechanism test is also performed alongside the other tests and in case of the nonconformity of brakes, taking the elevator into operation is not allowed. This is the main distinguishing points between elevators and cranes.

2. THE IMPORTANCE OF DEFLECTION AGAINST THE APPLIED FORCES

Suitable rails have to be used for the safety mechanism of the elevators to be in working order and provide the required safety. Rail calculations are performed to determine whether these rails are appropriate or not. It is asked to take into account the features stated in the following article.

*“ **EN 81-20, 5.7.2.1.1** The guide rails, their joints and attachments shall withstand the loads and forces imposed on them in order to ensure a safe operation of the lift.*
The aspects of safe operation of the lift concerning guide rails are:
a) car, counterweight or balancing weight -guidance shall be assured;
b) deflections shall be limited to such an extent, that due to them:
1) unintended unlocking of the doors shall not occur;
2) operation of the safety devices shall not be affected; and
3) collision of moving parts with other parts shall not be possible.
***5.7.2.1.2** The combination of deflections of guide rails and deflections of brackets, play in the guide shoes and straightness of the guide rails shall be taken into account in order to ensure a safe operation of the lift.”*

3. GROUND RULES ACCEPTED FOR CALCULATION

As it can be understood from the two abovementioned articles, it is not desirable that the total deflection of rails and brackets during braking be over the allowable values. However, there are some terms accepted in these calculations. The following terms were accepted in order to shape the calculations.

***" EN 81-20, 5.7.2.3.4** In the load cases "normal use" and "safety device operation" the rated load Q of the car shall be evenly distributed over those three quarters of the car area being in the most unfavourable position.*
However, if different load distribution conditions are intended after negotiations (0.4.2), additional calculations shall be made on the basis of this condition, and the worst case shall be considered.
The braking force of safety devices shall be equally distributed on guide rails.
NOTE: It is assumed that the safety devices operate simultaneously on the guide rails.

***" EN 81-50, 5.10.2.1** Calculating the bending stresses in the different axis of the guide rail (**Figure 4**), it can be assumed that:*
-The guide rail is a continuous beam with flexible fixing points at distances of the length l;
- The resultant of forces causing bending stresses act in the middle between adjacent fixing points;
- Bending moments act on the neutral axis of the profile of the guide rail."

When the common articles related to the subject in the standard are examined, if we are to choose the ones with regard to our topics among the acceptances for rail calculations:

1. ***The resultant of forces causing bending stresses act in the middle between adjacent fixing points;***
2. ***The braking force of safety devices shall be equally distributed on guide rails.***
3. ***It is assumed that the safety devices operate simultaneously on the guide rails."***

4. SUB-ACCEPTANCES IN THE STANDARD'S ACCEPTANCES

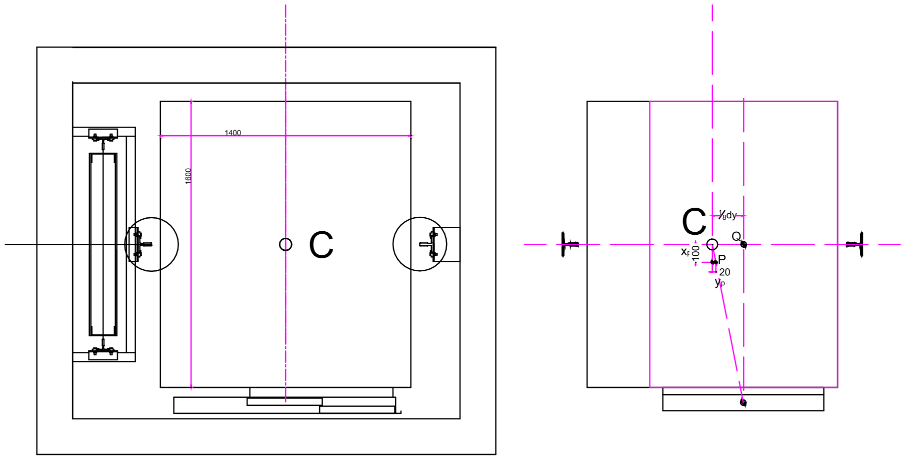
These acceptances made for rail calculations to be performed at a minimum level can mostly be given credence but it is required to specify two points for these conditions to be realized. The first one is that the two points where it is ensured that the brackets and joint bars do not stretch against these forces and stay rigid without creating an additional deflection; and the second one is that the bracket is ensured to show needed endurance against brake-side force which will lag at first between a range of 0.01-0.1 seconds when the first braking happens.

Brakes do not lag at the same time even if the standard says, "It was regarded that the security mechanism operated synchronously on guide rails." One side will lag 0.01-0.1 secs before the other one due to the several reasons such as the side where regulator rope exist is also the first side that tractive power occurs, gaps in the mechanic system, gaps in the arm that conveys the movement, torques in the materials, conditions of the springs that regulate the brake arms, and variations in distances of mechanic brakes to the rail. Brake block that lags first will be exposed to more force than the other side and it will has longer brake mark.

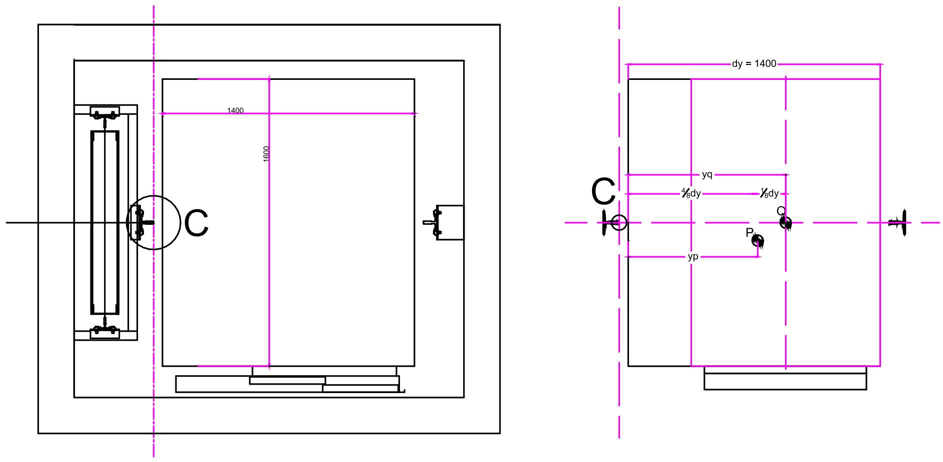
All of our colleagues who attend to brake tests can observe this in practical terms. Brake mark of one of the sides always starts 0.39-0.78 inches (1-2 cm) before and creates a longer braking mark compared to the other one. Then, braking occurs one-sided when it first starts, the car skids to that side and braking forces occur towards this side first due to the one-sided lag. After 0.01-0.1 secs. the brake on the other side also lags and distributes the forces to both rails equally. In order for the standard's acceptances to be rightly, it is required that the brackets offset these resultant forces and do not disrupt their own rigid structures during this first time slice. If the bracket and the material it hinges upon (wall or separation profile) shows extra flexibility, rail of the brake on the other side of the car further skids from lag distance together with the first skidding and may cause the other side of the brake fail. After the first skidding, comes the second one and this will cause the brake that first lags to go off the rail as the second side does not lag. Flexing of bracket and joint material during braking may produce serious results. These should be included in the calculations as points to take into consideration in places where especially the counter weight brackets partitions are used or there are more than one elevator in a well and the partition is made of profile materials.

5. PRELIMINARY FORCES DURING BRAKING

If we come to observe the situation accepted by the standard, it is understood that the braking occurs together on both rails. So, the point to be taken as the axis should be the C point. In order to calculate the side force, moment arms should be taken according to the central point. This is a calculation method we accept during braking in rail calculations.

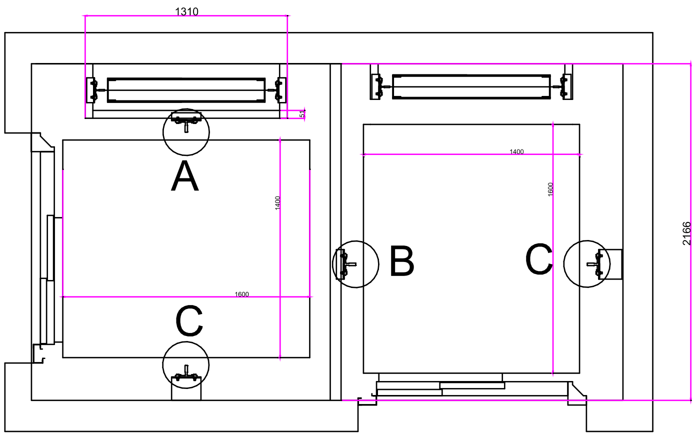


However, let's assume that the brake on the left lags first in the first braking moment. In this situation, braking axis to be taken will be the butt of left rail. It is required to move C point here and calculate the moment arms accordingly.



6. WELL IMPLEMENTATION

In order to explain this better, we examine the side forces that occur in an implementation where there are two elevators having 2.204 lbs (1000 kg) rated load with 55*62 inches (1400*1600 mm) car area in a well and their effects on brackets. Since we assume that vertical forces (F_z) are counterbalanced by the rail, its effect on brackets is at minimum level. Thus, they will not be taken into consideration. In every three situation, a well settlement like the below one was used to analyze bracket and braces.



Firstly, we'll find the center of gravity of the car having total (car and frame) P=2425 lbs (1100 kg), car C=1763 lbs (800 kg), door K=220 lbs (100 kg), load Q=2204 lbs (1000 kg), Dx=62 inches (1600 mm), Dy= 55 inches (1400 mm), center deviation of the door 6.69 inches (170 mm), door 35.4 inches (900 mm).

800*x = 100*(902-x)

800x = 90200-100x

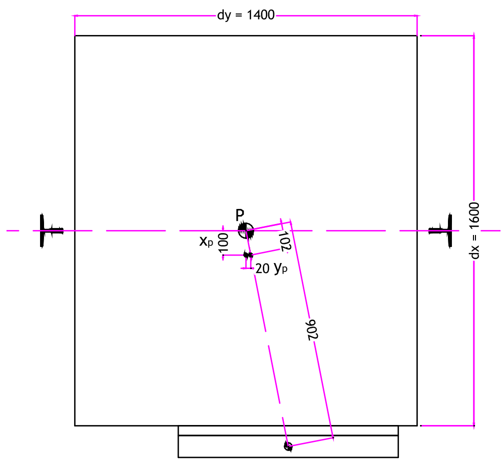
900x =90200

X_p =˜100 mm

By the help of chart

Y_p=0.78 inches (20 mm) center of gravity is found.

From now on the total car weight will be taken as 2.645 lbs (1200 kg) including the door suspension.



When brake lags on the left rail as one-sided, we can separately write Fx and Fy formulas for both situations.

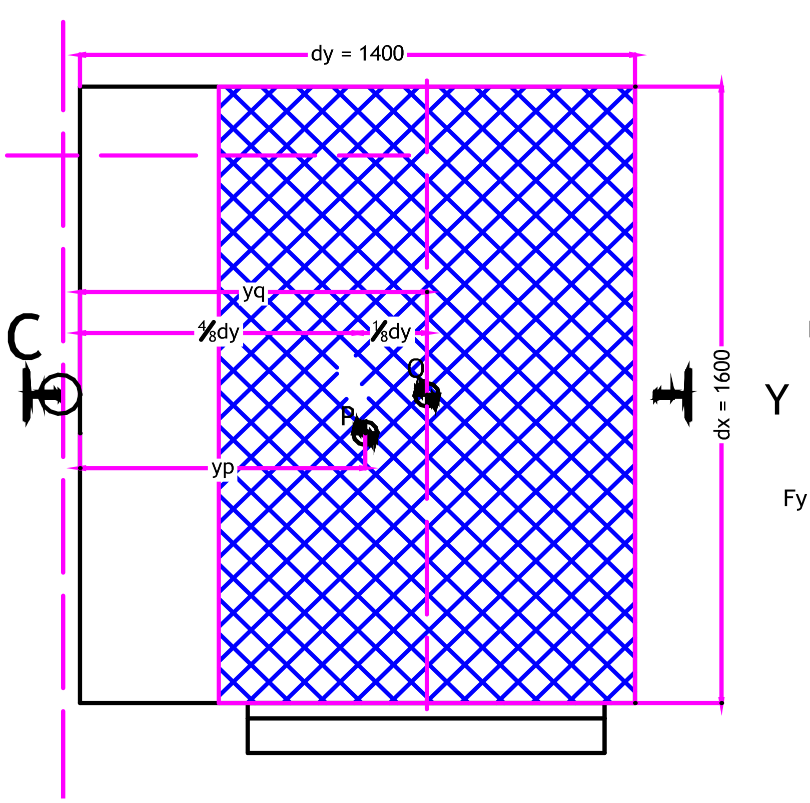
a) Bending force of guide rail regarding Y axis arising out of guide forces.

$$F_x = [k_1.g_n.(Q.x_q+P.x_p)] / (h.n)$$

b) Bending force of guide rail regarding X axis arising out of guide forces.

$$F_y = [k_1.g_n.(Q.y_q+P.y_p)] / (h.n/2)$$

Status 1



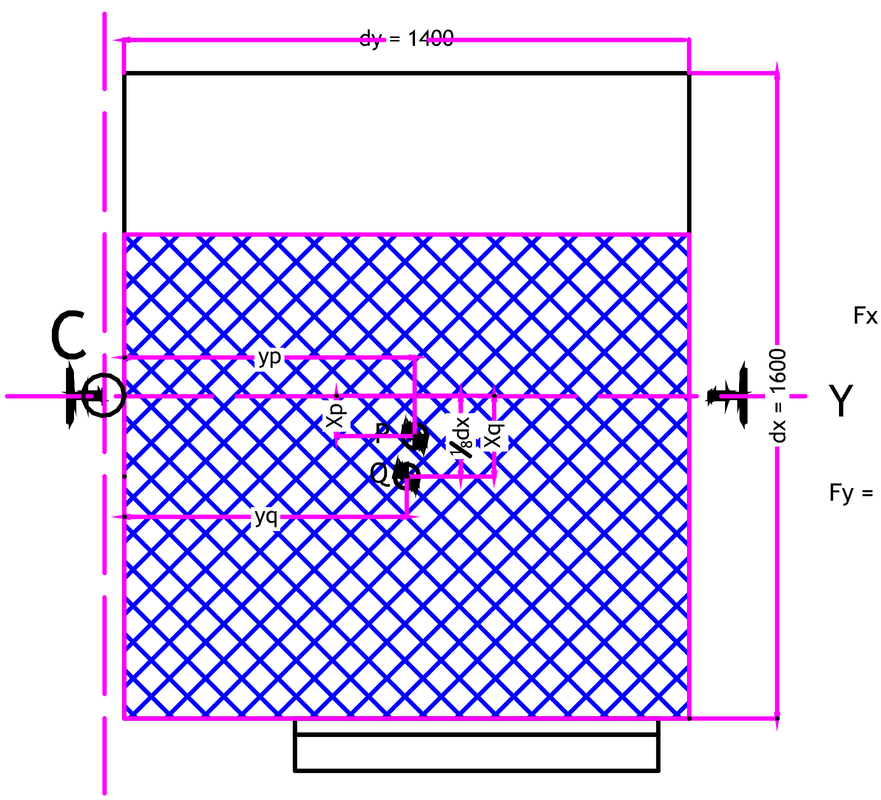
Fx = k1.gn(Q*Xq + P*Xp) / h*n

Fx = 2*9.81 (1000*0 + 1200*100) / 3300*2
Fx = 356 N

Fy = k1.gn(Q*yq + P*yp) / h*n/2

Fy = 2*9.81 (1000*875 + 1200*720) / 3300*2/2
Fy = 10339 N

Status 2



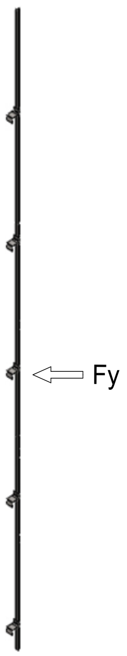
Fx = k1.gn(Q*Xq + P*Xp) / h*n

Fx = 2*9.81 (1000*200 + 1200*100) / 3300*2
Fx = 951 N

Fy = k1.gn(Q*yq + P*yp) / h*n/2

Fy = 2*9.81 (1000*700 + 1200*720) / 3300*2/2
Fy = 9298 N

According to these calculations, the largest Fy force to effect bracket occurs at the first status. The status to occur on bracket when the braking happens just across the bracket will be examined. If a braking occurs near the bracket, strength of the rail to this force will be very low since the distance between the two rail braces will be 2L.



If the found F_y force is effective in a place near the full brace, the strength that the rail shows this force will happen based on the other two braces if the brace, where the case occurs, does not show any strength. Distance between two braces is taken as (2+2) 4.00 mt. In this situation, if we are to calculate the stress and deflection on the rail, it should be:

$\sigma_{bending}$ =M/W = 3FyL/16W =3*10339*4000/(16*20870)

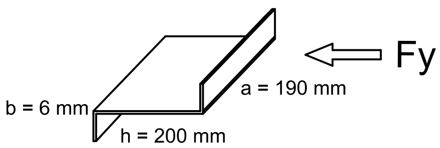
$\sigma_{bending}$ = 371,55 N/mm2 , must be < 205 N/mm^2.

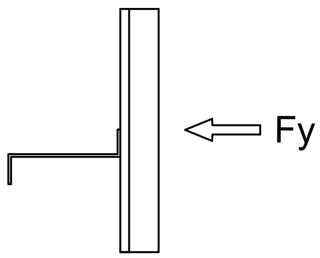
δ_y = (0.7 * FY * L^3) / (48 * E* IX)

δ_y =(0.7*10339*4000^3)/48*2.1*10^5*1020000)

δ_y = 1.77 in (45.05 mm) , must be < 0.196 in (5 mm).

As it is seen, it is not possible for the rail to have a strength in such force and distance if the bracket does not show strength. Thus, strength of the rail can be ignored in these kinds of calculations. It should be the strength of the brackets that must counterbalance the F_y force as strength. If the bracket cannot have a satisfactory strength against this force, there will develop large deflections while the safety of the elevator and safety intervals will all get into danger.

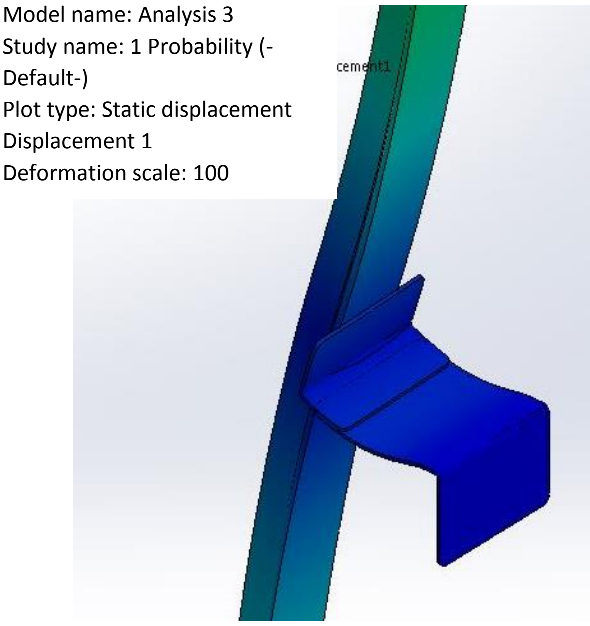


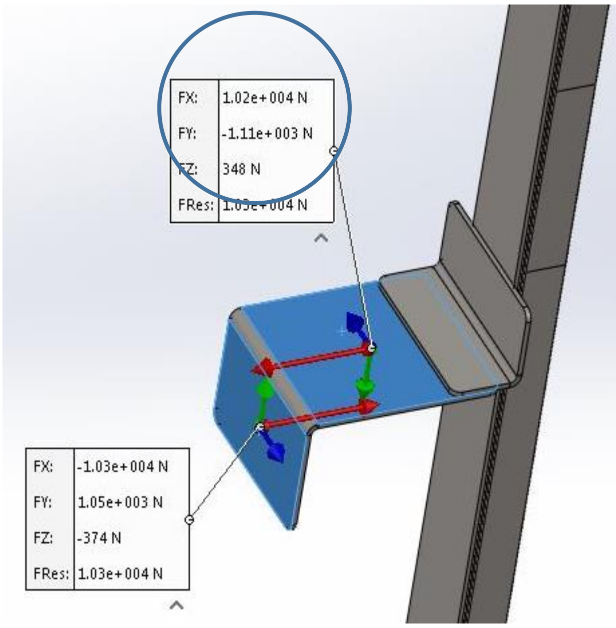


7. EXAMINATION OF BRACKET UNDER FORCE

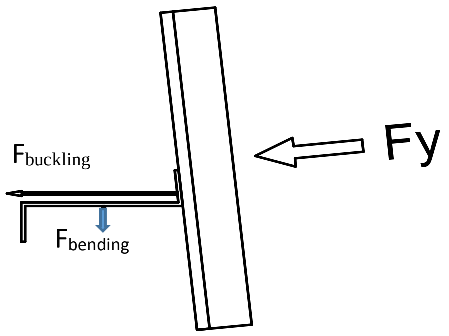
Bracket and rail was patterned on Solid program, previously calculated F_y and F_x forces were applied on 90*75*16 B type rail connected between the braces. Bracket was assumed as a beam with one side is stable (Wall) and other one is walking. F_x force has very low values compared to F_y force but the importance of it will be addressed in the examination of load elevator. Now the emphasis will be on F_y force. In the examination performed as a result of patterning, it was seen that the force was not only trying to bend but also buckling. As it can be seen in the figure below, an buckling occurs on the rail due to the force and this force tries to inflect the bracket. According to the measurement, it was seen that an inflection force around 6-8 degree occurred and the worst situation which is 8 degree was used in the calculations.

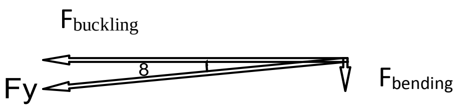
When it is examined on the forces in the patterning, it is seen that there is a force trying to inflect with one-tenth of the force which tries to bend. This is caused by the component of "sin(6)*F_y". F_y force is shown as Fx in the patterning.





If the force is split into components as a result of this twist in the F_y force effecting the bracket, buckling and bending forces will show up. In calculations, the worst situation which was a twist with 8 degree was taken. It was thought that occurrence of more tilting due to the base and top brackets can only be possible by the destruction of brackets. This sets forth the importance of bracket calculations. Bending and buckling words are used in accordance with the standard language.





$\sigma_{top} = \tau_{buckling} + \sigma_{bending}$

$\tau_{buckling} = F_y*\text{Cos } 8 /A$

$\sigma_{bending} = (3*F_y*\text{Sin}(8)*L)/(16*W)$

8. CALCULATION APPROACH FOR UNIFLECTED BRACKETS

For brackets without flange inflection, the following generalization can be made: (For inflected materials, the abovementioned formula that will calculate the strength momentum should be used.)

Since Cos (8) is very close to one, it can be ignored.

$$\tau_{buckling} = F_y/A = F_y/(a*b)$$

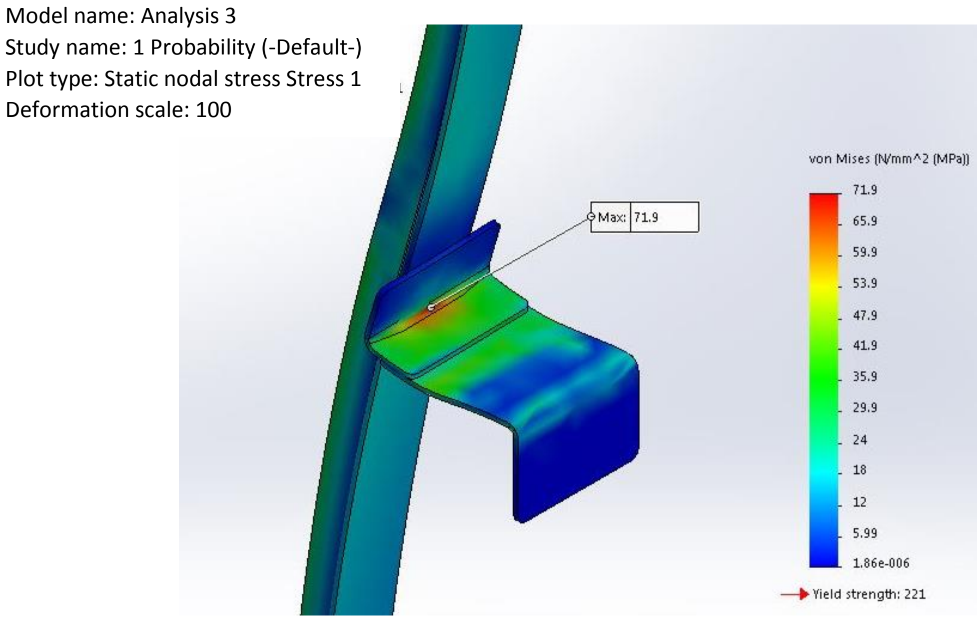
$$\sigma_{bending} = M/W = (3*F_y*Sin8*L)/(16*W)$$

Sin (8) = 0.1391~ 0.14 can be taken. $W = a*b^2/6$, $L=h$

$$\sigma_{bending} = (3*F_y*0.14*h)/(16*a*b^2/6) = 0.16*(F_y*h)/(a*b^2)$$

$$\sigma_{top} = F_y/(a*b) + 0.16*(F_y*h)/(a*b^2)$$

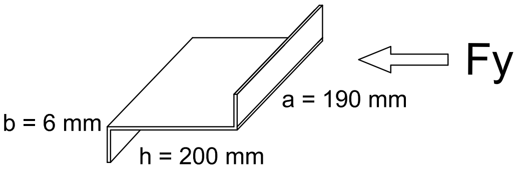
$$\sigma_{top} = F_y*(b+0.16*h)/(a*b^2)$$



The value found according to the formula seems to be very close to the calculation of bracket (0.23 inches/6 mm thickness, 7.87/200 mm inches length and 7.48 inches/190 mm width) performed with Solid. Central point value of wall bracket was taken as 55 N/mm² in the program while a value of 57.43 N/mm² was found through calculation method.

$$\sigma_{top} = 10339*(6+0.16*200)/(190*36)$$

$$\sigma_{top} = 57.43 \text{ N/mm}^2$$



A table can be prepared according to several rated loads and car dimensions by using this approach. The table was only created to provide an insight, and calculations for companies' own implementations should be performed abstractively. Executing a production based on this table may cause inaccurate results in the event that used materials and measurements are different

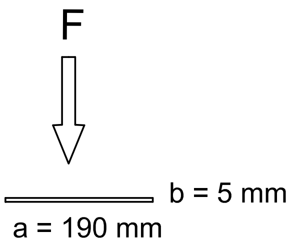
TABLE 1

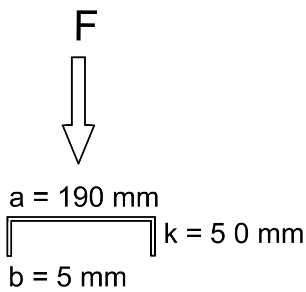
H=3300 mm, centralized door, stresses should be o<90 N/mm2 for dy status of the wide side in the car.													
Rated Load Q kg		**300 kg**		**450 kg**		**600 kg**		**800 kg**		**1000 kg**		**1250 kg**	
Rated load Q +Car weight P Kg		300	400	450	700	600	800	800	1000	1000	1200	1250	1400
Car sizes dx, dy (big size is dy)		900	1000	1000	1200	1200	1300	1300	1400	1400	1600	1400	2000
One-sided Fy Force N		2303,88125		4503,71625		5990,09125		8323,7		11653,18		17613,54375	
Console height = h mm	**Console width = a mm**	**wall thickness = b mm**	**Stress N/mm²**	**wall thickness = b mm**	**Stress N/ mm²**	**wall thickness = b mm**	**Stress N/ mm²**	**wall thickness = b mm**	**Stress N/ mm²**	**wall thicknes s = b mm**	**Stress N/ mm²**	**wall thickness = b mm**	**Stress N/ mm²**
50	190	2	30,31	2	59,26	3	38,53	3	53,54	4	46,00	4	69,53
50	190	3	14,82	3	28,97	4	23,65	4	32,86	5	31,89	5	48,21
70	190	3	19,13	3	37,40	3	49,74	4	41,62	4	58,27	5	60,07
70	190	4	11,52	4	22,52	4	29,95	5	28,39	5	39,74	6	44,29
100	190	3	25,60	3	50,04	3	66,56	4	54,76	5	51,52	6	56,65
100	190	4	15,16	4	29,63	4	39,41	5	36,80	6	37,48	7	43,51
130	190	3	32,07	3	62,68	4	48,87	4	67,90	5	63,30	6	69,01
130	190	4	18,79	4	36,74	5	32,54	5	45,21	6	45,66	7	52,59
150	190	3	36,38	3	71,11	4	55,17	4	76,67	5	71,15	7	58,65
150	190	4	21,22	4	41,48	5	36,57	5	50,82	6	51,11	8	46,35
200	190	3	47,16	4	53,33	4	70,94	5	64,84	6	64,74	7	73,78
200	190	4	27,28	5	35,08	5	46,66	6	46,24	7	48,82	8	57,94
250	190	3	57,93	4	65,19	5	56,75	6	55,98	7	58,83	8	69,53
250	190	4	33,35	5	42,67	6	40,28	7	42,02	8	46,00	9	56,08

Admissible stress rate on horizontal beams is given as $\sigma_{em} < 90$ N/mm^2 in TS 1812 standard article 2.6.6.2 chart 3. Generally values over 60 N/mm^2 are not preferred. Because we have two main acceptances in these formulas.

1. First acceptance for progressive safety gear the impact factor is taken as k_1=2. As we know by the practice, brakes may not show a progressive effect at all times in this respect. It is clear that k_1 value will increase more if the brake cannot fully manage the expected slipping movement.
2. Our second acceptance point is that we take that both the brackets and partition materials are stable to each other, and the wall connections themselves. It is clear that these connections made by using mechanic anchor or bolt are not this much rigid and may have flexing.

Thus, I recommend the admissible stress value be taken as 60 N/mm^2 and at most 70 N/mm^2 in consideration of these acceptances. These values can be increased for the brakes with different rigid connections and if their behavior is certain. When the stress should reach to limit values or if the materials thickness should be over 0.23 inches (6 mm), impacting inflection to the material increases the strength momentum extremely. Strength momentum difference between bracket with inflection impacted 1.96 inches (50 mm) on the flanges and plain bracket. Inflections should be preferred instead of material thickness. If an implementation called rib is used, strength momentum should be measured and provided by the manufacturer company. Strength momentums are calculated for two materials below:





$W_1 = a*b^2/6 = 190*5*5/6 = 791.66$ mm^3

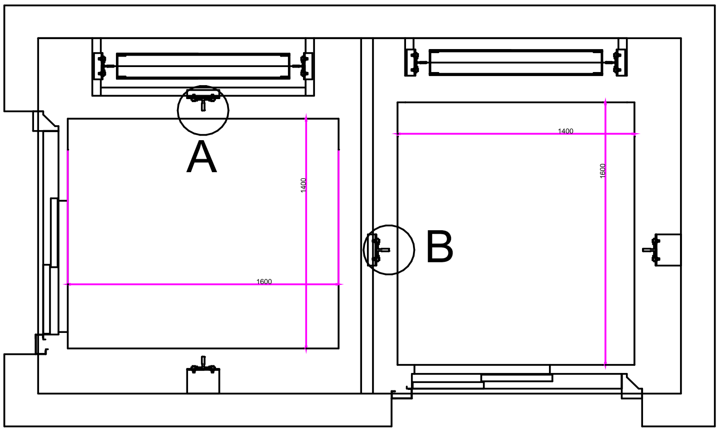
$W_2 = (a*k^3 - a_1*k_1^3)/6k = (190*50^3 - 180*45^3)/(6*50) = 24491.66$ mm^3

$W_2 / W_1 = 30.937$ times more

A little inflection increases the strength of a material almost at least 30 times more. This strength cannot be gained through increasing the thickness of a material.

9. VIEW ON COUNTERWEIGHT FRAME AND PARTITION BRACKETS

Car measures and calculated F_y force -which was previously used for the calculation- can also be used for examining the strength values of counterweight frame bracket (A point) and partition bracket (B point). Bracket joint material for these elevators were used in two different situation. In the first situation, the material was used vertically while it was used horizontally in the second situation. It was again accepted that the braking occurred near the bracket. Once again, it was assumed that counter strength of rail to F_y force would be weak and it was ignored. Bracket should directly counter the force. Since the bracket was connected to the joint material (0.39-0.78 inches), no bending was seen on the bracket itself. The force directly have effect on the joint material.



As it can be seen on the drawing above, forces on A and B points have effect on the central point of the brackets. Bracket joint material's both sides which were connected to the wall were accepted as stable (instead of 1/2, 3/4 multiplier stems from here). The force that tried to bend joint material would be F_y and that tried to inflect would be F_x however, its effect was not taken into consideration since F_x was a small force and the section thickness of bracket total material was big. It will be required to find the rate of moment trying to bend joint material to strength momentum in order to find stress. Since the bad case is the medium effect of the force, this formula will be used.

$$\sigma_{bending} = M/W = [((1/2)*F_y)*((1/2)*L)*(1/2)]/(W)$$

$$\boldsymbol{\sigma_{bending} = F_y*L/(8*W)}$$

This formula will be used for both joint material.

10. STRESS ON COUNTERWEIGHT PARTITION BRAKCET

For partition material, 3.14*1.96*0.19 inches (80*50*5 mm) sheet material with 0.59 inches

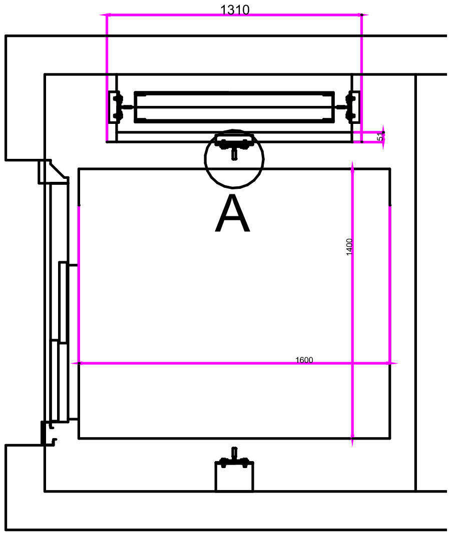
(15 mm) bended flanges was used.

For the force tried to be bent, previously calculated F_y will be taken.

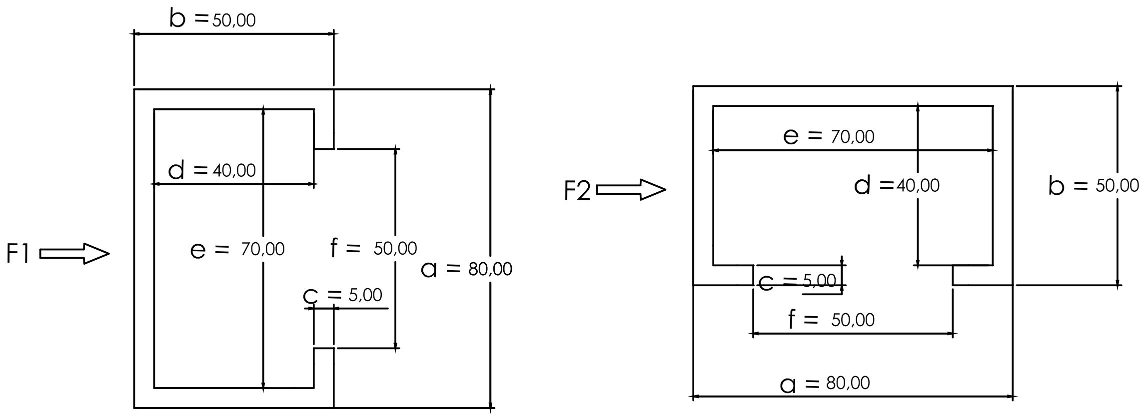
$$M = F_y*L/8$$

$$M = 10339*1310/8$$

$$M = 1693011.25 \text{ Nmm}$$



Two different cases were studied to calculate strength momentum of the material. The used material were calculated separately in vertical and horizontal positions. In F_1 position the material was used as vertical and for this W_1, in horizontal position W_2 strength momentums were calculated.



For vertical position;

$$W_1 = (a*b^3-e*d^3-f*c^3)/(6*b)$$

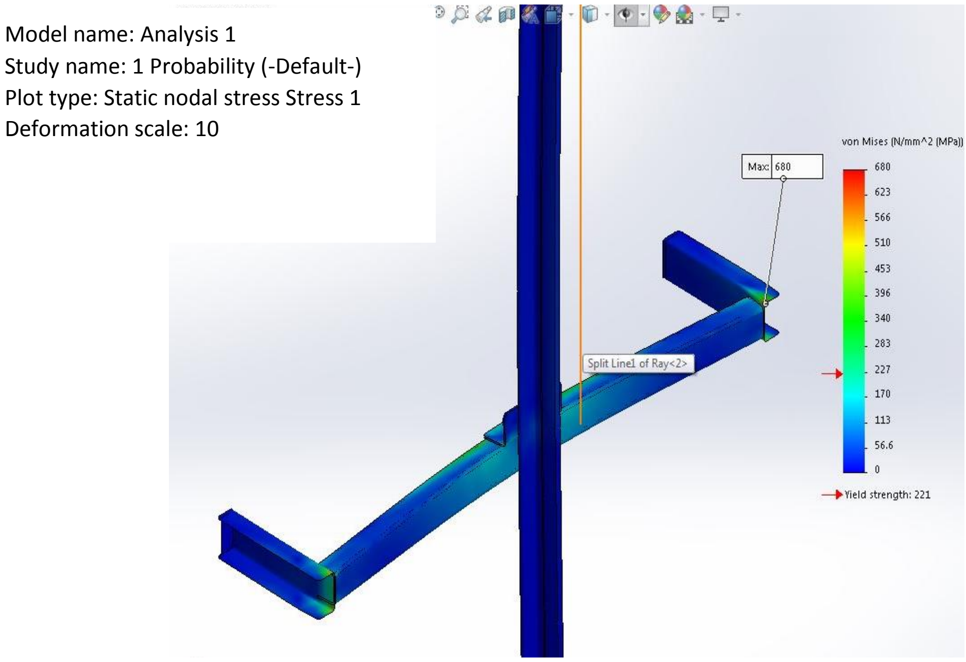
$$W_1 = (80*50^3-70*40^3-50*5^3)/(6*50)$$

$$W_1 = 18379.16 \text{ mm}^3$$

$$\sigma_{bending} = M/W = 1693011.25 / 18379.16$$

$$\sigma_{bending} = 92,115 \text{ N/mm}^2$$

In patterning conducted on Solid, stress for this case was found as 100 N/mm^2 approximately.



Stress for horizontal status

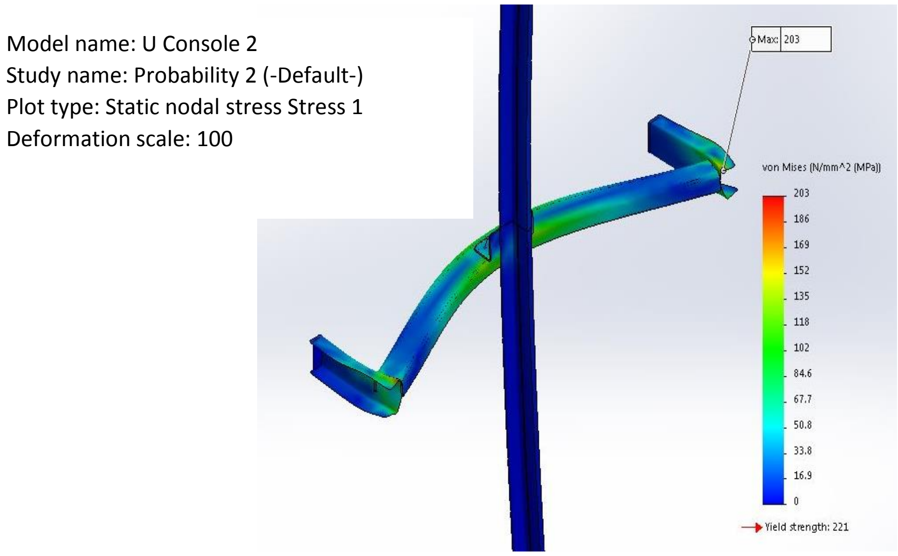
$W_1 = (b*a^3-d*e^3-c*f^3)/6*a$

$W_1 = (50*80^3-40*70^3-5*50^3)/(6*80)$

$W_1 = 23447.91\ mm^3$

$\sigma_{bending} = M/W = 1693011.25/23447.91$

$\sigma_{bending} = 72.203\ N/mm^2$



In patterning conducted on Solid, stress for horizontal case was found as 70 N/mm^2 approximately. Then, calculations by hand are in conformity with the program. Material that is not acceptable in vertical position becomes adequate in horizontal position since its strength momentum increases. In this sense, the materials used for counterweight sections should be calculated and controlled. If 3.14 inches (80 mm) NPU is used instead of sheet material, calculations will be like the followings:

	x - x			y- y		
U	Jx mm4	Wx mm3	Ix mm	Jy mm4	Wy mm3	Iy mm
80	1060000	26500	31	194000	6360	13,3

Stress for vertical status;

$\sigma_{bending} = M/W = 1693011.25/6360$

$\boldsymbol{\sigma_{bending} = 256.76\ N/mm^2}$

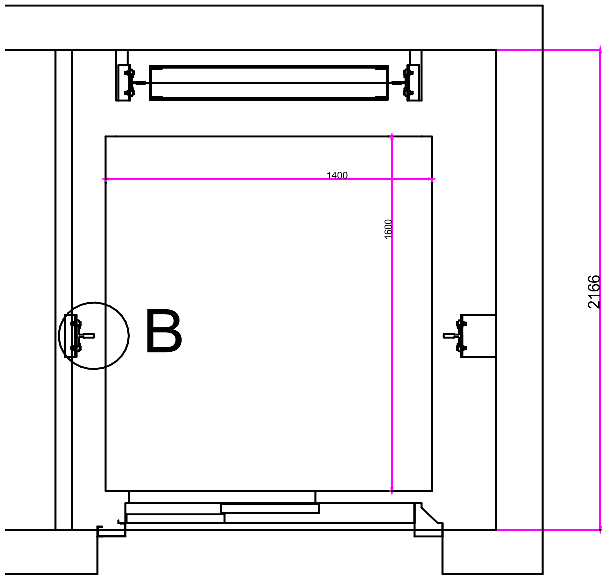
Stress for horizontal status;

$\sigma_{bending} = M/W = 1693011.25/26500$

$\boldsymbol{\sigma_{bending} = 61.62\ N/mm^2}$

If NPU material is placed horizontally, it is seen that functioning of the bracket becomes almost impossible. NPU material is almost fivefold resistant material in horizontal position.

11. STRESS ON WELL PARTITION BRACKET



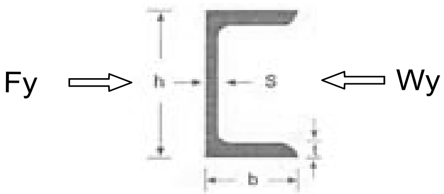
140 NPU profile was used for well partition bracket. Again, calculations will be made for both cases and it will be compare with Solid.

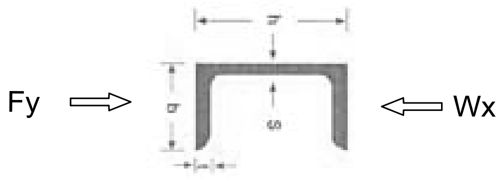
$\sigma_{bending}$ = M/W =((1/2)*F_y)*((1/2)*L)*(1/2)/(W) = F_y*L/(8*W)

M = F_y*L/8

M = 10339*2166/8

M = 2799284.25 Nmm





According to the direction of the effecting force, W_y should be applied when the material is used vertically and W_x should be applied when the material is used

Strength and inertia momentums will be taken from the table for both directions.

U	x - x			y- y		
	Jx mm4	Wx mm3	Ix mm	Jy mm4	Wy mm3	Iy mm
140	6050000	86400	54,5	627000	14800	17,5

When the material is placed vertically, the Stress;

$\sigma_{bending}$ = M/W = 2799284.25/14800

$\sigma_{bending}$ = 189.14 N/mm < 90 N/mm^2

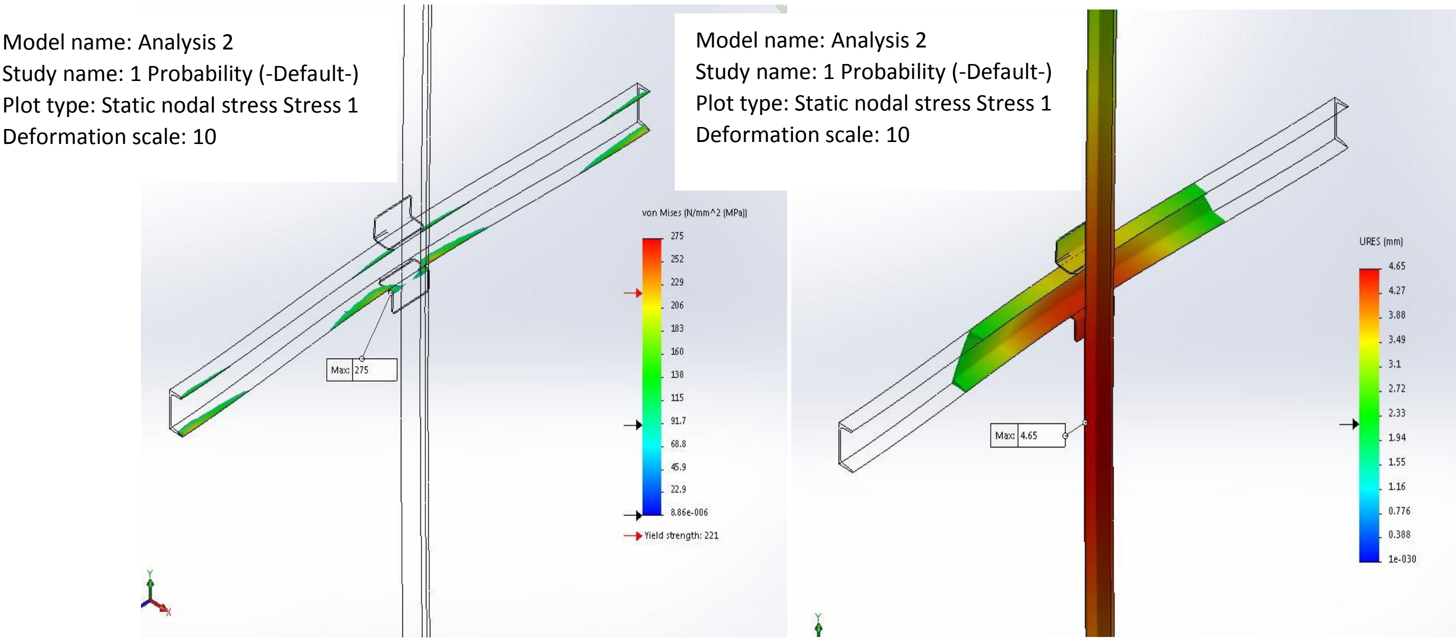
Deflections;

$\delta_Y = (0.7.F_y.L^3) / (48. E.I_Y) \quad <\delta_{em}$

$\delta_Y = (0.7*10339*2166^3)/(48*2.1*10^5*627000)$

δ_Y = 11.636 mm, must be < 5 mm

The results obtained in Solid are given below. The results are very close to each other.



When the material is used horizontally, the Stress;

$\sigma_{bending} = M/W_x$ = 2799284.25/86400

$\sigma_{bending}$ = 32.399 N/mm^2

Deflections;

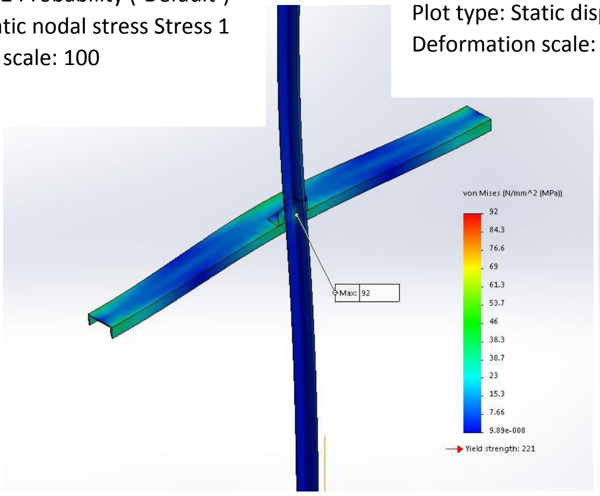
$\delta_Y = (0,7.F_Y.L^3) / (48. E.I_X) \quad <\delta_{em}$

$\delta_Y = (0,7*10339*2166^3)/(48*2,1*10^5*6050000)$

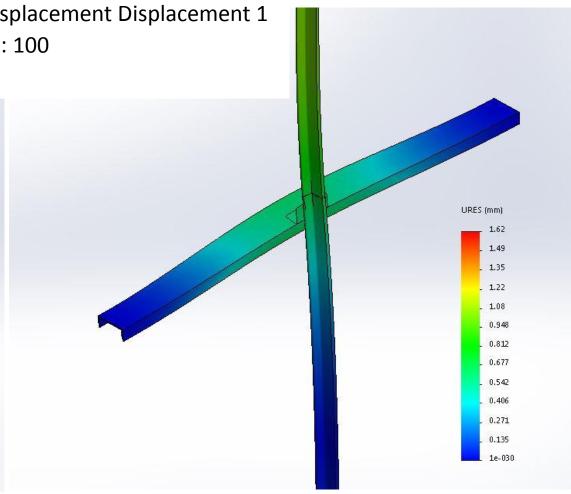
δ_Y =1.2 mm

The results obtained in Solid are given below. In this case, the results are very close to each other.

Model name: Assem 1
Study name: 2 Probability (-Default-)
Plot type: Static nodal stress Stress 1
Deformation scale: 100



Model name: Assem 1
Study name: 2 Probability (-Default-)
Plot type: Static displacement Displacement 1
Deformation scale: 100

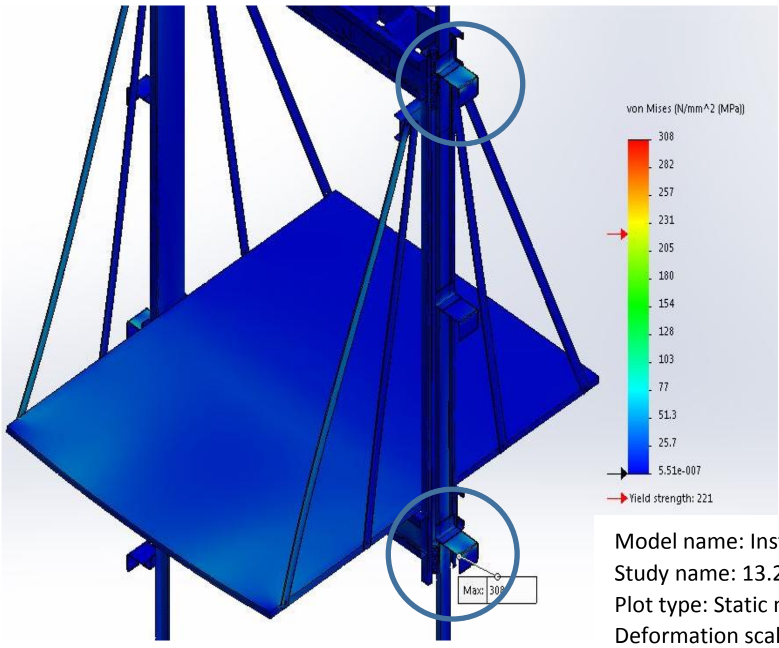


As it is seen, the material is of no use apart from providing a display when it is placed vertically. It is not possible for partition material to perform partitioning and to ensure required stoppage. Strength momentums of these kinds of NPU materials creates almost a fivefold difference for horizontal and vertical cases. During the implementations, it is very important for the elevator in question to stay within the security limits in terms of both stress and deflection numbers. Below, there is a table prepared by taking safe stress value as 60 N/mm^2 due to the reasons stated previously and next to it, strength values of the materials are given. Attention must be paid that the value of W_y (if the used material is utilized vertically) and W_x (if the used material is utilized vertically) is higher than the minimum stress value given on the table.

NOTE: The table was only created to provide an insight, and calculations for companies' own implementations should be performed abstractively. Executing a production based on this table may cause inaccurate results in the event that used materials and measurements are different.

12. BRACKET STRESSES DURING LOADING ON ELEVATORS FOR HEAVY GOODS

Bracket calculation for elevators, should be made for F_y force as we did it at the beginning. However, F_x force that shows itself during loading and unloading in these elevators brings another condition into question for calculation on brackets.



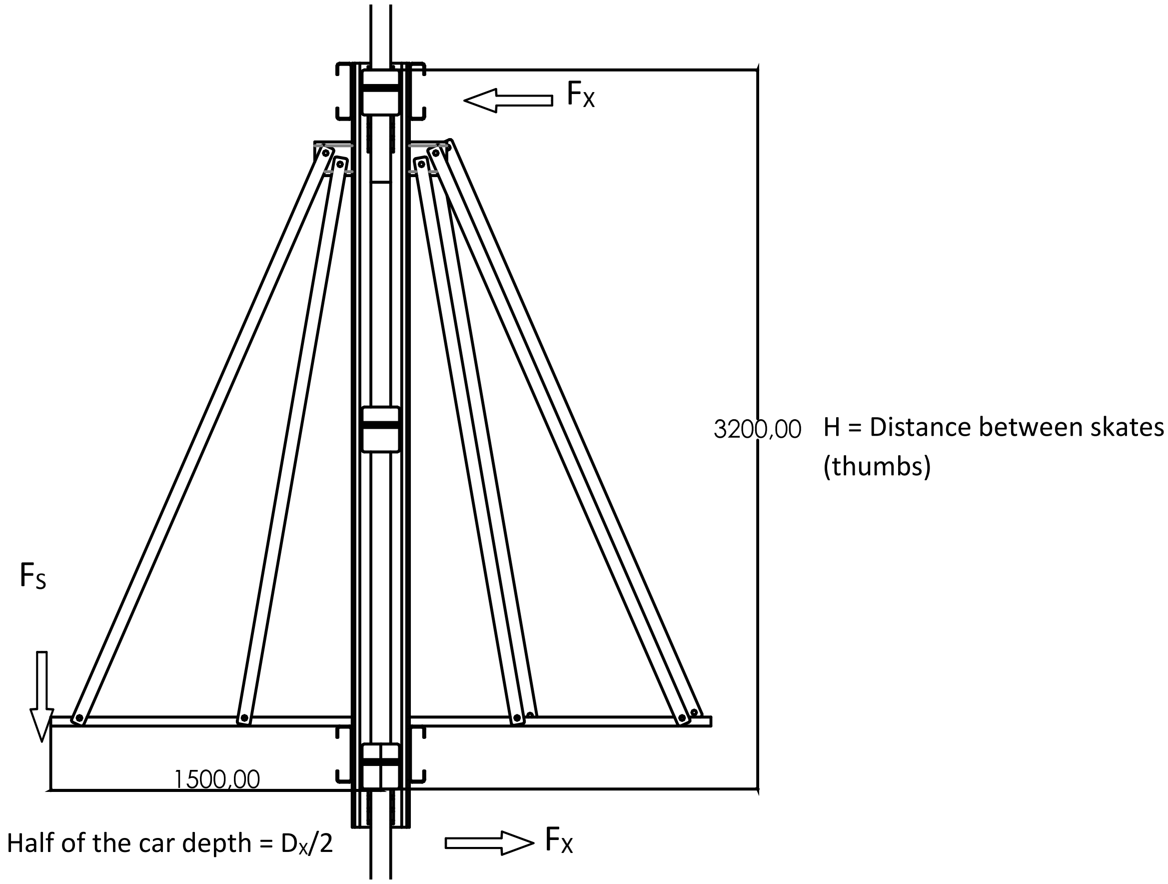
Model name: Installation
Study name: 13.227 lbs (6000 kg) (-Default-)
Plot type: Static nodal stress Stress 1
Deformation scale: 10

TABLE 2

Rated Load Q kg	300	450	600	800	1000	1250
Car weight	400	700	800	1000	1200	1400
Car sizes dx, dy	900/1000	1000/1200	1200/1300	1300/1400	1400/1600	1400/2000
One-sided Fy N	2303.88	4503.71	5990.09	8323.7	11653.18	17613.54
Console height= h mm	Minimum strength value mm3	Minimum strength value mm3	Minimum strength value mm3	Minimum strength value mm3	Minimum strength value mm3	Minimum strength value mm3
800	3,839.80	7,506.18	9,983.48	13,872.83	19,421.97	29,355.90
900	4,319.78	8,444.46	11,231.42	15,606.94	21,849.71	33,025.39
1000	4,799.75	9,382.73	12,479.35	17,341.04	24,277.46	36,694.88
1100	5,279.73	10,321.00	13,727.29	19,075.15	26,705.20	40,364.36
1200	5,759.70	11,259.28	14,975.23	20,809.25	29,132.95	44,033.85
1300	6,239.68	12,197.55	16,223.16	22,543.35	31,560.70	47,703.34
1400	6,719.65	13,135.82	17,471.10	24,277.46	33,988.44	51,372.83
1500	7,199.63	14,074.09	18,719.03	26,011.56	36,416.19	55,042.31
1600	7,679.60	15,012.37	19,966.97	27,745.67	38,843.93	58,711.80
1700	8,159.58	15,950.64	21,214.90	29,479.77	41,271.68	62,381.29
1800	8,639.55	16,888.91	22,462.84	31,213.88	43,699.43	66,050.78
1900	9,119.53	17,827.19	23,710.77	32,947.98	46,127.17	69,720.26
2000	9,599.50	18,765.46	24,958.71	34,682.08	48,554.92	73,389.75
2200	10,559.45	20,642.00	27,454.58	38,150.29	53,410.41	80,728.73
2300	11,039.43	21,580.28	28,702.51	39,884.40	55,838.15	84,398.21
2400	11,519.40	22,518.55	29,950.45	41,618.50	58,265.90	88,067.70
2500	11,999.38	23,456.82	31,198.39	43,352.60	60,693.65	91,737.19
2600	12,479.35	24,395.10	32,446.32	45,086.71	63,121.39	95,406.68
2700	12,959.33	25,333.37	33,694.26	46,820.81	65,549.14	99,076.16
2800	13,439.30	26,271.64	34,942.19	48,554.92	67,976.88	102,745.65
2900	13,919.28	27,209.91	36,190.13	50,289.02	70,404.63	106,415.14
3000	14,399.25	28,148.19	37,438.06	52,023.13	72,832.38	110,084.63

VALUES FOR NPU PROFİLES						
	x - x			y- y		
U	Jx mm4	Wx mm3	Ix mm	Jy mm4	Wy mm3	Iy mm
65	575000	17700	25,2	141000	5070	12,5
80	1060000	26500	31	194000	6360	13,3
100	2060000	41200	39,1	293000	8490	14,7
120	3640000	60700	46,2	432000	11100	15,9
140	6050000	86400	54,5	627000	14800	17,5
160	9250000	116000	62,1	853000	18300	18,9
180	13500000	150000	69,5	1140000	22400	20,2
20	19100000	191000	77	1480000	27000	21,4
220	26900000	245000	84,8	1970000	33600	23
240	3600000	300000	92	2480000	39400	24,2
260	48200000	371000	99,9	3170000	47700	25,6
280	62800000	448000	109	3990000	57200	27,4
300	80600000	535000	117	4950000	67800	29

It was seen that the greatest stress during loading was on the brackets in the patterning made on Solid. While there was no dangerous stresses on suspension parts that all loading calculations are made for, extra stress occurred on the brackets due to the F_s threshold force during loading process. For rail and car calculations, stresses are calculated and due precautions are taken for threshold force. However, bracket calculation is not usually taken into consideration while these calculations are done. Thus, detachment from the walls, bending and door rubbing due to the tilt of car are often seen on brackets -especially the ones driven with mechanic anchor- after a while.



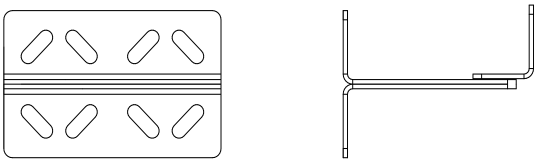
Under normal operating-loading conditions, F_x force on the rail will have an effect on the bracket as the force that directly effects the bracket when the threshold is exactly opposite of the it.

$F_x = [g_n * P * (x_p - x_s) + F_s * (x_i - x_s)] / (h * n)$

In our patterning, since there is a central suspension, it is: $x_S = 0$ Since there was not a shift in the car's center of gravity, it was not calculated as well. Thus, it was taken as $x_p = 0$. P is neutral. However, it should be taken into account if x_p value occurs due to the door variation in real practice. Only the load that has an effect on the threshold was taken into account. 13.227 lbs (6000 kg) load was applied on an area of 3.93 inches (100 mm). In this case, F_x;
$F_x = [9.81*6000*1450] / (3200*2)$

$F_x = 13335.46$ N

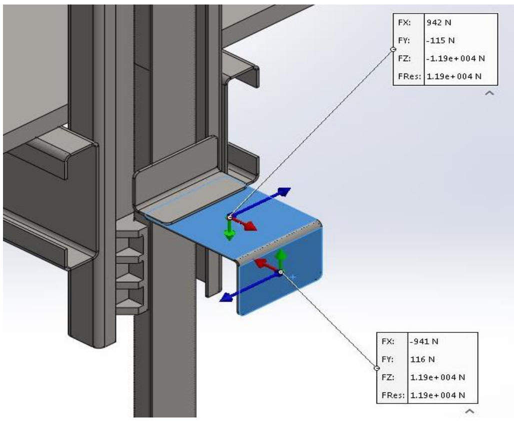
Loads on brackets should also be regarded in as much as rail and suspension calculations in service elevators. These forces have effect on the bracket bolts as shear forces, and as tractive force on wall connections. Special brackets should be used for these kinds of elevators. If you don't have any, you can have a stronger structure by connecting two brackets back-to-back. Especially for the elevators with forklift loadings, it should be ensured that the brackets are resistant to tractive forces during the impacts of load by using chemical anchor.

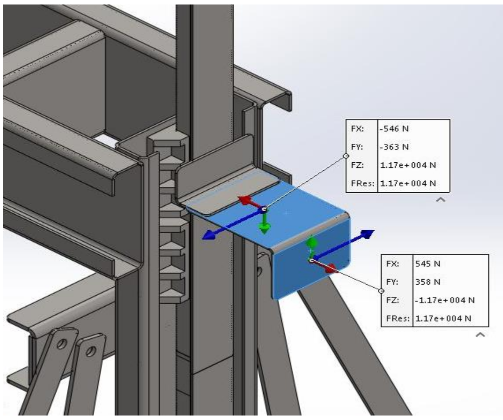


Double folded bracket sample for service

Pattering that we performed on Solid also provided results similar to this. The decreases caused by the suspension connections of smaller force which occurred in the program was also considered but the loads laying on the bracket are around these levels anyway.

13. CONCLUSION





Bracket calculations are essential just as the rail and car calculations for elevators in terms of safety. In order for the deflection calculations on rails to be accurate, it is required to ensure that brackets and bracket joint bars are rigid enough. Otherwise, the conducted rail calculations will go wrong and there will be problems in braking and loadings. It is supposed that these kinds of bracket problems are not seen, but flexing on bracket is always missed out since the regulator and braking mechanism are deemed guilty because of the problems of braking in many tests. However, it is not possible to escape from these kinds of cases in reality. It should be known that the main guilty of many accidents resulted with injuries or death is brackets or partition profiles. Hope that the brackets are not passed unnoticed among all those calculations. We believe that this issue will gain due importance.

RESOURCES

1. **TS EN 81-20 Lifts -** Safety Rules for the Construction and Installation of Lifts - Passenger and Foods Lifts - Part 20: Passenger and Goods Lifts, October 2014
2. **TS EN 81-50 Safety Rules for the Construction and Installation of Lifts -** Examinations and Tests - Part 50: Design Rules, Calculations, Examinations and Tests of Lift Components, October 2014
3. **TS EN 81-1+A3 Lifts -** Safety Rules for the Construction and Installation - Part 1: Electrical Lifts, **TS 1812 Calculation, Design and Construction Rules of Lifts** (for Electrical Passenger and Goods Lifts), December 1988
4. **Mukavemet Değerleri (Strength Values),** November 2009 M. GÜVEN KUTAY
5. **Asansör Uygulamaları (Elevator Aplications),** November 2005 SERDAR TAVASLIOĞLU

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